Chlorinated Hydrocarbons and Total Mercury in the Prey of the White-tailed Eagle (*Haliaeetus albicilla L.*) in the Quarken Straits of the Gulf of Bothnia, Finland

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During the passed decade a drastic decline has been noticed in populations of several birds of prey (e.g. HICKEY and ANDERSON 1968, RATCLIFFE 1970). Also eggshell thinning of these birds has been reported by many authors (ODSJÖ 1971, McLANE and HALL 1972, KOIVUSAARI et al. 1972a). Changes in hatchability have been noticed in natural populations (NEWTON and BOGAN 1974, KOIVUSAARI et al., unpublished).

Nowadays it is widely accepted that the pollution of the environment by chlorinated hydrocarbons (DDT etc.), polychlorinated biphenyls (PCBs) and mercury has been the main reason for the changes mentioned above. These compounds have been detected in dead birds and addled eggs (e.g. BORG et al. 1969, KOEMAN et al. 1972, KOIVUSAARI et al. 1972b). Some white-tailed eagles found dead in the Baltic have had extremely high concentrations of DDT in the muscle, up to 36 000 ppm, PCB 17 000 ppm (fat weight basis) and mercury 26 ppm (wet weight basis) according to JENSEN et al. (1972b). The chlorinated hydrocarbons affect for instance the calcium metabolism by thinning eggshells of the birds (BITMAN et al. 1969). This has also been proved experimentally (LONGCORE et al. 1971). In hens BORG et al. (1969) have shown decrease in hatchability of the eggs in experimental conditions.

Parts of the Baltic are among the most contaminated marine areas in the world. In these areas environmental poisons have been detected in the prey species of the white-tailed eagle (JOHNELS et al. 1967, BORG et al. 1969, KARPPANEN et al. 1970).

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Our group has studied the diet of the white-tailed eagle population for about ten years in the Quarken Straits of the Gulf of Bothnia (KOIVUSAARI et al., unpublished). Based on these studies some of the main species of the prey were chosen for further analyses concerning pollutants mentioned above.

The aim of this study was to investigate how high concentrations of some chlorinated hydrocarbons and mercury exist in some of the main prey of the eagle and to find out which species cause most of the contamination of the eagle via its food in this particular population.

MATERIALS AND METHODS

The material was collected from the territories of the white-tailed eagle (Haliaeetus albicilla L.) in the Quarken Straits area of the Gulf of Bothnia, Finland ($62^{o}50'$- $63^{o}30'$N and $21^{o}10'$- $21^{o}30'$E). The fishes were captured with nylon nets and the birds were shot in 1972-1973. The samples were excised and kept at -24^{o}C until analyzed.

The extractions and clean-up for the residue analyses (DDT, DDD, DDE, PCBs, aldrin, lindane) were carried out by the method of HATTULA (1973).

Determination of mercury (Hg) was done with a flameless atomic absorption spectrophotometer (Coleman model MAS-50 mercury analyzer) according to the method described by JANATUINEN (unpublished).

RESULTS

The results are described in table 1.

Mercury, PCB and DDE were detected in all animals studied. DDT was present in all fishes and mallards (Anas platyrhynchos), DDD in one goosander (Mergus merganser) and one mallard. Traces of lindane were detected

TABLE 1. Total Hg, PCB, DDE and DDT in some prey species of the white-tailed eagle in the Quarken Area of the Gulf of Bothnia, Finland. Concentrations are given in ppm/wet weight (mean ± S.E.) of dorso-lateral muscle of fishes, pectoral muscle of birds and hind leg muscle of the mammal.

	N	Fat %	Total Hg	PCB	DDE	DDT
Esox lucius	25	0.8±0.08	0.20±0.01 (n=21)	0.08±0.01	0.01±0.002	0.02±0.004
Leuciscus idus	3	1.1 0.18	0.27 0.05	0.05 (n=2)	0.02 (n=2)	0.004 (n=2)
Cottus quadricornis	9	1.2 0.13	0.68 0.07	0.19 0.07	0.04 0.01	0.03 0.01
Acanthocottus scorpius	5	0.6 0.06	0.49 0.05	0.09 0.01	0.04 0.02	0.005 0.001
Anas platyrhyncos	5	1.6 0.08	0.05 0.01	0.16 0.05	0.06 0.01	0.008 0.002
Aythya fuligula, A. marila	2+2	1.7 0.17	0.11 0.006	0.04 0.01	0.01 0.001	n.d.
Melanitta fusca	1	2.4	-	0.03	0.01	"
Mergus merganser ad.	2	2.8	0.83	4.89	1.21	"
" " juv.	1	1.2	0.17	0.09	0.03	"
" serrator ad.	1	1.3	0.93	1.25	0.24	"
" " juv.	4	1.4	0.21 0.02	0.24 0.04	0.05 0.009	"
Ondatra zibethica	1	1.5	-	0.11	0.08	"

in two pikes (Esox lucius), aldrin in one pike, two mallards and one pochard (Aythya fuligula).

Fishes

The highest concentrations of each residue studied in fish were detected in the fourhorn sculpin (Cottus quadricornis). Also the great sculpins (Acanthocottus scorpius) were more contaminated than the pikes and the ides (Leuciscus idus).

Birds

According to our results the most contaminated birds in the prey of the white-tailed eagle were adult mergansers, which are mainly fish-eaters. In these birds the concentrations were about 10-40 times higher than in the other birds studied which are not fish-eaters (mallards and pochards). The concentrations in the juvenile mergansers were about twice as high as that of the latter species.

Mammals

The only mammal analyzed was a muskrat (Ondatra zibethica) that showed about same concentrations as the mallards and pochards.

DISCUSSION

Because mercury, DDE and PCB-compounds exist in the prey of the white-tailed eagle in all animals studied they must have a marked effect in the contamination of this eagle. This is also the case with DDT and its metabolite (DDD), although DDT was present chiefly in fishes and DDD only occasionally in the prey.

Analyses made by other authors in Finland of partly same and partly some other main species of prey of the eagle, mallards, mergansers, black headed gulls (Larus

ridibundus), great crested grebes (Podiceps cristatus), black grouses (Lyrurus tetrix), pikes, perches (Perca fluviatilis), roaches (Rutilus rutilus) and breams (Abramis bramus), show about equal level of contamination concerning the species in the same positions in the food chains as the species analyzed in this study (HÄSÄNEN and SJÖBLOM 1968, KARPPANEN et al. 1970, HATTULA et al., unpublished).

The fishes studied by us are stationary species and reflect the low local pollution in the study area compared with more polluted areas of the Baltic (JOHNELS et al. 1967, 1968, JENSEN 1972a) and USA (HENDERSON et al. 1969, 1971), where the highest concentrations detected are roughly about 500-2 000 times higher as to DDT and about 200 times higher as to PCBs calculated by wet weight. In the study area the mercury concentration of the pikes are of "the natural level" according to JOHNELS et al. (1968). The birds in the prey of the white-tailed eagle are all migratory except for the Tetraonids. Because of this fact they do not necessarily reflect the local contamination. Especially fish-eating species get obviously most of their residues from the wintering areas in southern Baltic and North Sea (HENRIKSSON et al. 1966).

Young white-tailed eagles migrate mainly to southern Baltic and Central Europe. Mature birds stay normally the whole year in their breeding areas and thus they do not "fetch biocides" from areas more contaminated than the Quarken Straits (WAHLBERG et al. 1970). The breeding result, however, is as poor as in the more contaminated areas of the Baltic than the study area (HELANDER 1970, LOOFT and NEUMANN 1971). Also the biocide concentrations of the addled eggs are of high level all over the Baltic (JENSEN et al. 1972, HELANDER 1970, KOIVUSAARI, et al. unpublished).

We believe that one of the most important reasons for the poor breeding results of the white-tailed eagle (especially the hatchability) are the combined effects of studied pollutants originating for the most part from the fish-eating species in its prey (mergansers and great crested grebes) which pass their winter in the southern Baltic. Although the winter diet, e.g. black grouses, hares (Lepus timidus), and miscellaneous fishes, of the eagles in the Quarken Straits is relatively pure according to our preliminary results they get some mercury from sculpins which are left on the ice by local fishers. This mercury (added to the basic level of mercury already present in tissues) eaten by the eagles before and during the egg-laying season in early spring (February-March) might have some effect on the viability of eggs.

The white-tailed eagles and their productivity in the Quarken Straits do not necessarily indicate local biocide contamination but reflect the contamination of the wintering areas of the most important bird species in the prey.

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